

New derivatives of echinocandine, their preparation process  
and their use as antifungals.

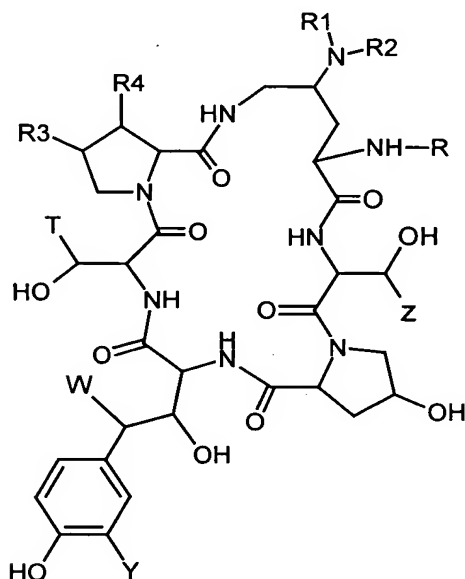
The present invention relates to new derivatives of  
5 echinocandine, their preparation process and their use as  
antifungals.

A subject of the invention is in all the possible isomer  
forms as well as their mixtures, the compounds of formula  
(I):

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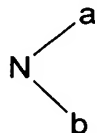
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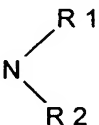
25 in which

either  $R_1$  and  $R_2$  identical to or different from one another,  
represent a hydrogen atom, a hydroxyl radical, a linear,  
branched or cyclic alkyl radical containing up to 8 carbon  
atoms optionally interrupted by an oxygen atom optionally  
30 substituted by a halogen atom, an OH radical, an

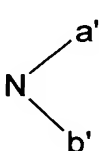


35 radical, a and b identical to or different from one another,  
representing a hydrogen atom or an alkyl radical containing  
up to 8 carbon atoms, a and b can optionally form with the  
nitrogen atom a heterocycle optionally containing one or more

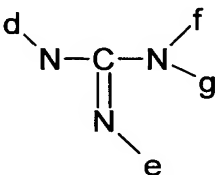
additional heteroatoms,  
or R<sub>1</sub> forms with the endocyclic carbon atom

5 carrying the  radical a double bond and or R<sub>2</sub>

represents an XRa radical, X representing an oxygen atom or  
10 an NH or N-alkyl radical containing up to 8 carbon atoms and  
Ra represents a hydrogen atom, a linear, branched or cyclic  
alkyl radical containing up to 8 carbon atoms optionally  
substituted by one or more halogen atoms, by one or more OH,  
CO<sub>2</sub>H, CO<sub>2</sub>alk radicals, by an

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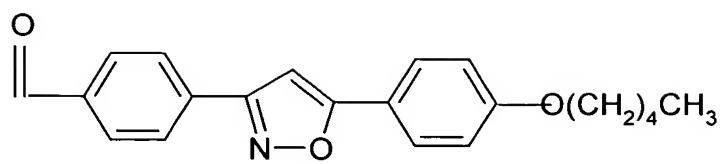
radical, a' and b' representing a hydrogen atom, an alkyl  
20 radical containing up to 8 carbon atoms, a' and b' can form a  
heterocycle optionally containing one or more additional  
heteroatoms and/or by a heterocycle containing one or more  
heteroatoms or R<sub>2</sub> represents a

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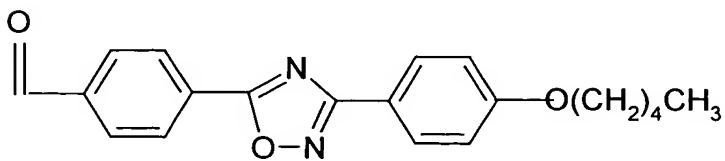
radical in which d, e, f and g represent a hydrogen atom or  
30 an alkyl radical containing up to 8 carbon atoms, f and g can  
moreover represent an acyl radical containing up to 8 carbon  
atoms, e and f can also form a ring optionally containing one  
or more heteroatoms,

R<sub>3</sub> represents a hydrogen atom, a methyl or hydroxyl radical  
35 R<sub>4</sub> represents a hydrogen atom or a hydroxyl radical  
R represents a radical chosen from the following radicals:

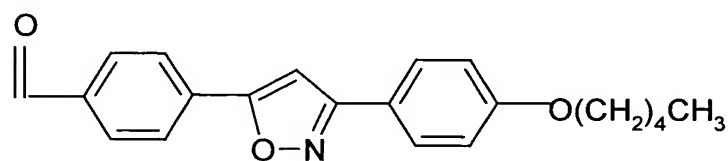
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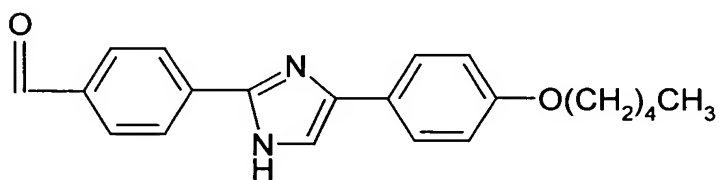
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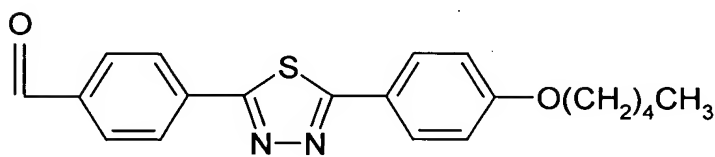
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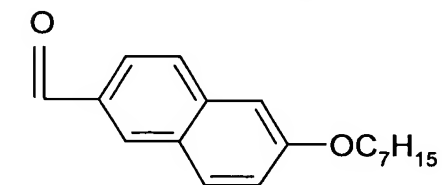
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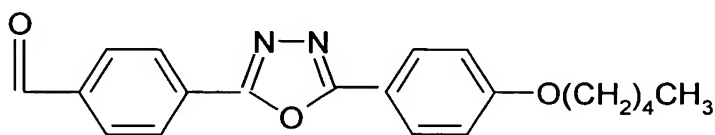
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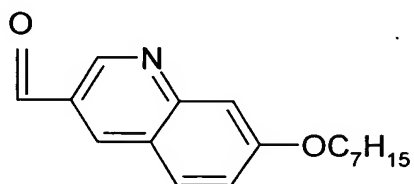
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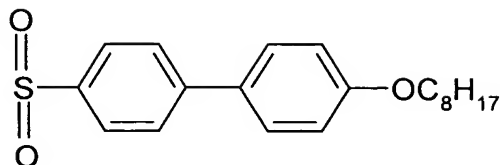


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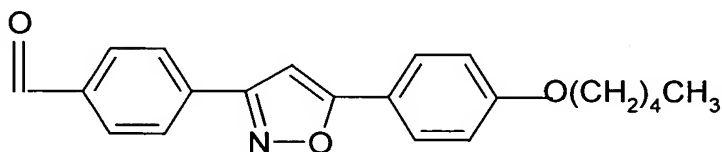
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T represents a hydrogen atom, a methyl radical, a  $\text{CH}_2\text{CONH}_2$ ,  $\text{CH}_2\text{C}\equiv\text{N}$  radical, a  $(\text{CH}_2)_2\text{NH}_2$  or  $(\text{CH}_2)_2\text{Nalk}^+\text{X}^-$  radical, X being a halogen atom and alk an alkyl radical containing up to 8 carbon atoms,  
 Y represents a hydrogen atom, a hydroxyl radical or a halogen atom or an  $\text{OSO}_3\text{H}$  radical or one of the salts of this radical,  
 W represents a hydrogen atom or an OH radical,  
 15 Z represents a hydrogen atom or a methyl radical, as well as the addition salts with acids of the products of formula (I).

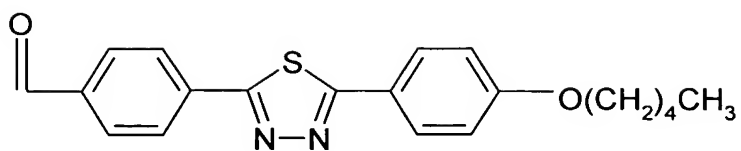
Among the addition salts with acids, there can be mentioned those formed with mineral acids, such as  
 20 hydrochloric, hydrobromic, sulphuric or phosphoric acid or with organic acids such as formic, acetic, trifluoroacetic, propionic, benzoic, maleic, fumaric, succinic, tartaric, citric, oxalic, glyoxylic and aspartic acids, alkanesulphonic acids, such as methane or ethane sulphononic acid,  
 25 arylsulphonic acids such as benzene or paratoluene sulphononic acids.

A more particular subject of the invention is the compounds of formula I in which T represents a hydrogen atom, those in which W represents a hydrogen atom, those in which Z represents a methyl radical, those in which Y represents a  
 30 hydrogen atom, those in which  $\text{R}_3$  represents a methyl radical, those in which  $\text{R}_4$  represents a hydroxyl radical and those in which R represents a

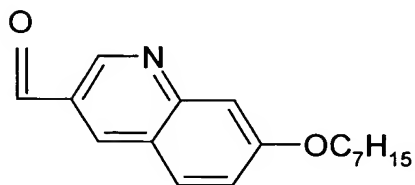
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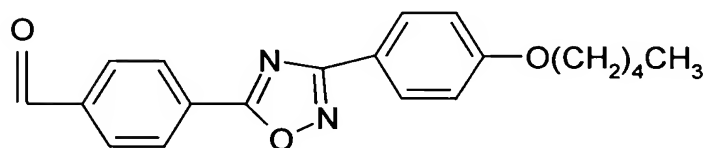
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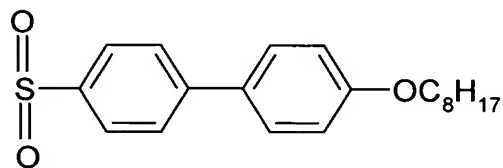


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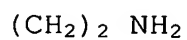
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radical  
or a

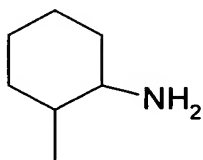


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radical  
those in which  $R_1$  represents a hydrogen atom,  
25 those in which  $R_2$  represents a

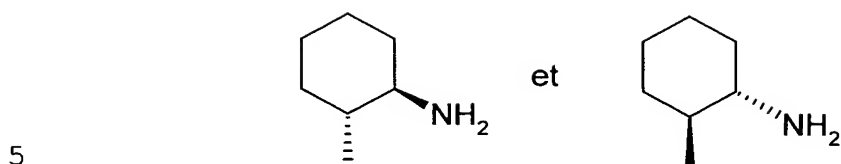


radical  
30 those in which  $R_2$  represents a

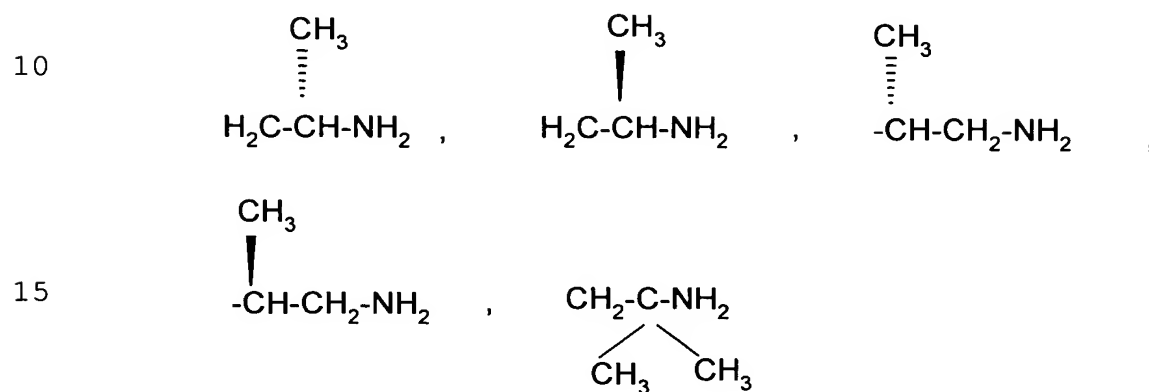


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radical  
and in particular the



radicals as well as those in which R2 represents a



radical.

20 A more particular subject of the invention is the compounds of formula I the preparation of which is given hereafter in the experimental part.

The compounds of formula (I) have useful antifungal properties; they are in particular active on *Candida albicans* and other *Candida* such as *Candida glabrata*, *krusei*, *tropicalis*, *pseudotropicalis*, *parapsilosis* and *Aspergillus fumigatus*, *Aspergillus flavus*, *Cryptococcus neoformans*.

The compounds of formula (I) can be used as medicaments in man or animals, in particular to combat invasive candidosis, digestive, urinary, vaginal or cutaneous candidosis, cryptococcosis, for example neuromeningeal, pulmonary or cutaneous cryptococcosis, bronchopulmonary and pulmonary aspergillosis and invasive aspergillosis in the immunosuppressed.

35 The compounds of the invention can also be used in the prevention of mycotic illnesses in the congenital or acquired immunosuppressed.

The compounds of the invention are not limited to a

pharmaceutical use, they can also be used as fungicides in fields other than the pharmaceutical field.

Therefore a subject of the invention is, as antifungal compounds, the compounds of formula (I) as well as their  
5 addition salts with acids.

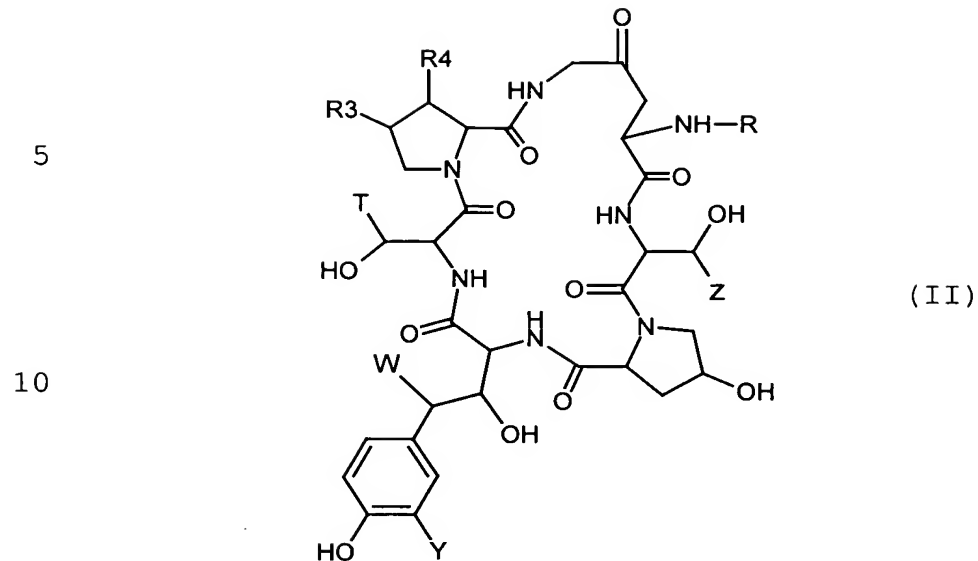
A subject of the invention is also the compounds of formula (I), as medicaments.

A most particular subject of the invention is the pharmaceutical compositions containing as active ingredient  
10 at least one compound of formula (I) or one of its addition salts with pharmaceutically acceptable acids.

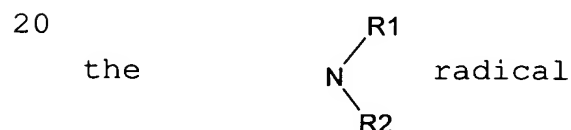
These compositions can be administered by oral, rectal, parenteral route or by local route as a topical application on the skin and mucous membranes, but the preferred routes  
15 are the oral and parenteral routes.

They can be solid or liquid and can be presented in the pharmaceutical forms commonly used in human medicine, such as for example, plain or sugar-coated tablets, gelatin capsules, granules, suppositories, injectable preparations, ointments,  
20 creams, gels; they are prepared according to the usual methods. The active ingredient or ingredients can be incorporated in the excipients usually used in these pharmaceutical compositions, such as talc, gum arabic, lactose, starch, magnesium stearate, cocoa butter, aqueous or  
25 non-aqueous vehicles, fatty matter of animal or vegetable origin, paraffin derivatives, glycols, various wetting, dispersing or emulsifying agents, preservatives.

A subject of the invention is also a preparation process for the compounds of formula (I) characterized in that a  
30 compound of formula (II)



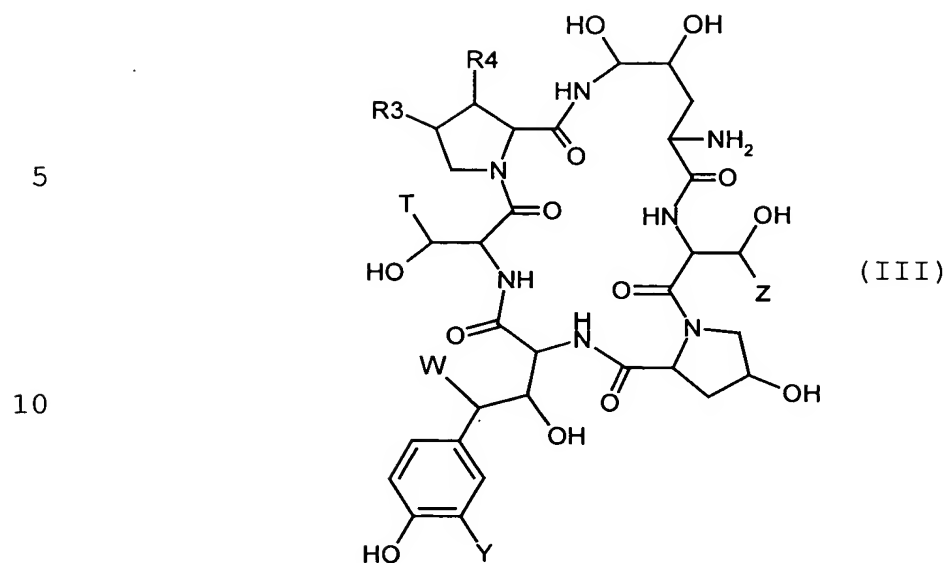
in which R, R<sub>3</sub>, R<sub>4</sub>, T, Y, W and Z retain their previous meaning, is subjected to the action of an amine or of an amine derivative capable of introducing



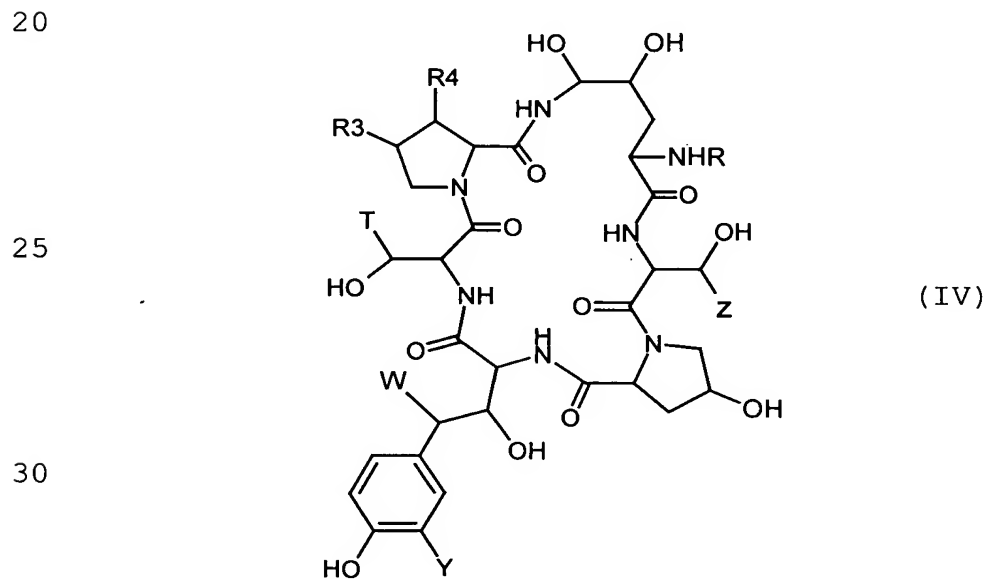
in which R<sub>1</sub> and R<sub>2</sub> retain their previous meaning and if  
 25 desired to the action of a reducing agent,  
 and/or of a functionalization agent of the amine,  
 and/or of an acid in order to form the salt of the product  
 obtained,  
 and/or of a separation agent of the different isomers  
 30 obtained,  
 and in this way the compound of formula (I) as defined above  
 is obtained.

The compounds of formula II used are new products and are in themselves a subject of the invention.

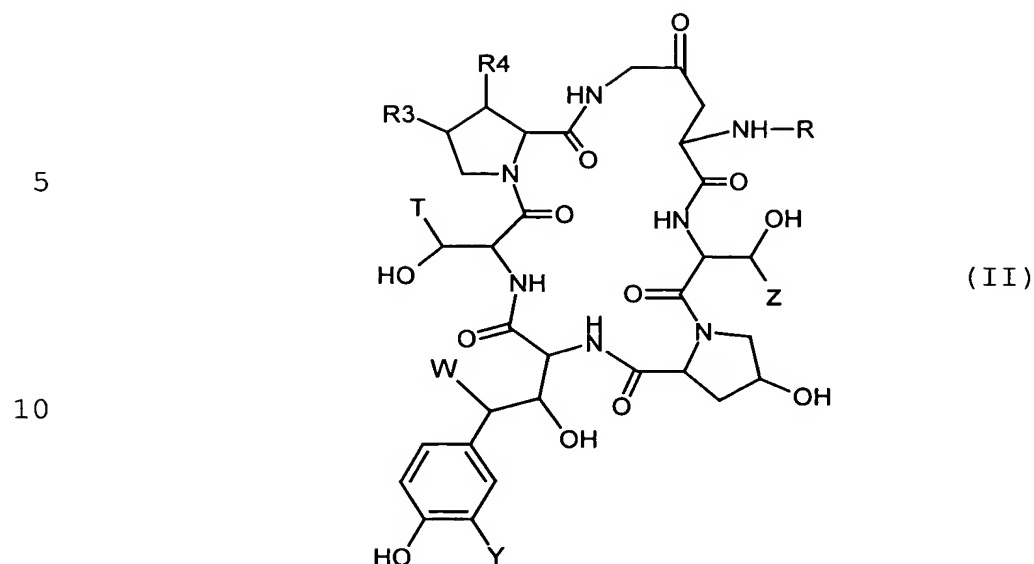
35 A subject of the invention is also a process characterized in that a compound of formula (III)



15 in which the different substituents retain their previous meaning is subjected to the action of an agent capable of replacing  $\text{NH}_2$  by  $\text{NHR}$ , R retaining its previous meaning in order to obtain the compound of formula (IV)



35 which is subjected to the action of trimethylsilyl iodide in order to obtain the corresponding compound of formula (II)



15 The compounds of formula III and IV used are new products and are in themselves a subject of the present invention.

Among the preferred products of formula III and IV, there can be quite particularly mentioned the products the  
20 preparation of which is given hereafter in the experimental part.

The following examples illustrate the invention without however limiting it:

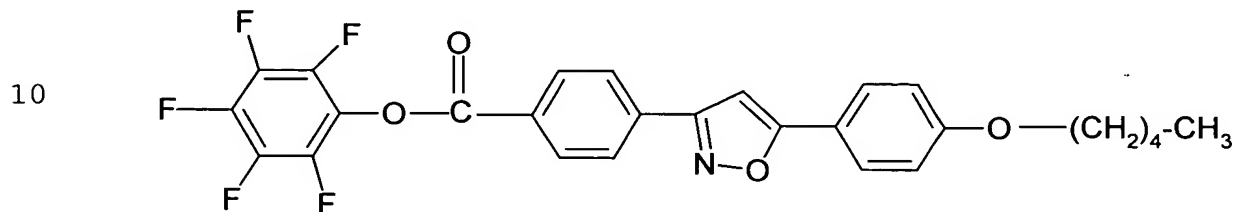
**Preparation 1: "nucleus" of deoxymulundocandine**

25 2 g of deoxymulundocandine is dissolved in 20 ml of DMSO. This solution is poured into a suspension containing 120 g of *Actinoplanes utahensis* FH2264 in 870 ml of a KH<sub>2</sub>PO<sub>4</sub>, K<sub>2</sub>HPO<sub>4</sub> buffer (pH: 6.8). The reaction mixture is maintained under agitation for 70 hours at 30°C. Filtration is carried  
30 out. The mycelium is washed with the phosphate buffer (pH: 6.8). The washing liquids and the filtrate are combined. The product obtained is chromatographed on a DIAION HP 20 resin and a product is obtained which is used as it is hereafter.

35 **EXAMPLE 1:** 1-[4-[(2-aminoethyl) amino]-N<sup>2</sup>-[[4-[5-[4-pentyl-oxy)-phenyl]-3-isoxazolyl]-phenyl]-carbonyl]-L-ornithine]-4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B (isomer A and isomer B).

STAGE A: 1-[(4R,5R)-4,5-dihydroxy-N2-[[4-[5-[4-(pentyloxy)-phenyl]-isoxazol-3-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B.

16.8 g of the product of Preparation 1 is introduced under agitation and a nitrogen atmosphere into 552 ml of DMF. The reaction medium is agitated for 5 minutes and 19 g of the ester of formula



is added.

Agitation is carried out for 29 hours, followed by filtering and concentrating under reduced pressure. The residue is taken up in ether, followed by triturating, separating, washing with ethyl ether and chromatography on silica eluting with a methylene chloride methanol mixture (85/15). In this way the expected product is obtained  $rf = 0.24$

STAGE B: 1-[4-oxo-N2-[[4-[5-[4-(pentyloxy)-phenyl]-isoxazol-3-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B.

6.12 ml of trimethylsilyl iodide is added to a suspension containing 16.1 g of the product of Stage A and 374 ml of acetonitrile is added. Then the reaction medium is heated for 15 minutes at 60°C followed by hydrolyzing with a saturated solution of sodium thiosulphate. After bringing to dryness under reduced pressure chromatography is carried out on silica eluting with a methylene chloride, methanol, water mixture 86-13-1. The sought product is obtained  $rf = 0.23$ .

Mass Spectrum

$MH^+ = 1083.6$

$MNa^+ = 1105.6$

STAGE C: 1-[4-[(2-aminoethyl)-amino]-N2-[[4-[5-[4-(pentyloxy)-phenyl]-3-isoxazol-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate (Isomer A and isomer B).

8.6 mg of NaBH<sub>3</sub>CN is introduced into a mixture of 120 mg of the product of the preceding stage, 2.4 ml of methanol, 60 mg of ethylenediamine diacetate in the presence of activated 4A siliporite. The reaction mixture is maintained under agitation and under a nitrogen atmosphere for 18 hours, followed by filtering and concentrating. The product obtained is purified by semi preparative HPLC eluting with an acetonitrile /H<sub>2</sub>O/TFA mixture (40-60-0.02 %). 14.5 mg of sought product is recovered.

10 Mass spectrum

1127+ = MH+

1149+ = Mna+

The following are recovered: Isomer A: 14.5mg

Isomer B: 17.5 mg

15 **EXAMPLE 2: trans-1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[5-[4-(pentyloxy)-phenyl]-3-isoxazolyl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate (Isomer A and Isomer B).**

Approximately 40 µl of acetic acid is added under agitation and under a nitrogen atmosphere to a solution containing 100 mg of the product obtained in Stage B of the preceding example 3 ml of methanol, 32 mg of (1R, 2R)(-)-1,2-diaminocyclohexane until a pH close to 6 is obtained, in the presence of activated 3A siliporite. Agitation is carried out for 5 minutes and 12 mg of NaBH<sub>3</sub>CN is introduced. The reaction mixture is maintained under agitation for 18 hours. followed by filtering and concentrating under reduced pressure. The product obtained is purified by semi-preparative HPLC (eluent CH<sub>3</sub>CN, H<sub>2</sub>O, TFA 50-50-0.02 %).

30 Isomer A wt= 11 mg

Isomer B wt = 14 mg

Mass spectrum

1181.5 MH+

35 **EXAMPLE 3: trans-1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[5-[4-(pentyloxy)-phenyl]-3-isoxazolyl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate (Isomer A and isomer B).**

Operating as in Example 2 with (1S, 2S)-(-)-1,2-

diaminocyclohexane, the following are obtained:

Isomer A = 7.4 mg

Isomer B = 10.8 mg

Mass spectrum

5 1181.5 = MH<sup>+</sup>

**EXAMPLE 4:** 1-[4-[(2(S)-aminopropyl)-amino]-N2-[[4-[5-[4-(pentyloxy)-phenyl]-3-isoxazolyl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate (Isomer A and isomer B).

10 By operating as in Example 1 the following are obtained:

Isomer A: 13 mg

Isomer B: 10 mg

**EXAMPLE 5:** trans-1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[3-[4-(pentyloxy)-phenyl]-1,2,4-oxadiazol-5-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate

15 **STAGE A:** 1-[(4R,5R)-4,5-dihydroxyN2-[[4-[3-[4-(pentyloxy)-phenyl]-1,2,4-oxadiazol-5-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B.

20 By operating as in Example 1 Stage A, the sought product is obtained.

Mass spectrum 1124 = MNa<sup>+</sup>

**STAGE B:** 1-[4-oxo-N2-[[4-[3-[4-(pentyloxy)-phenyl]-1,2,4-oxadiazol-5-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B.

25 By operating as in Example 1 Stage B, the sought product is obtained.

Mass spectrum 1106.6 = MNa<sup>+</sup>

30 1090.8 = MH<sup>+</sup>

**STAGE C:** trans-1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[3-[4-(pentyloxy)-phenyl]-1,2,4-oxadiazol-5-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate.

35 By operating as in Example 1 Stage C, starting from 150 mg of the product of Stage B, and 51.4 mg of (1S,2S)1,2-diaminocyclohexane, 165 mg of crude product is obtained which is purified by semi preparative HPLC (KROMASIL C18 column)

Mass spectrum:  $1204 = \text{MNa}^+$

**EXAMPLE 6:** 1-[4-[(2-aminoethyl)amino]-N2-[[4-[5-[4-(pentyloxy)-phenyl]-1,3,4-thiadiazol-2-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B trifluoroacetate.

A suspension containing 2 g of 4-[5-[4-(pentyloxy)-  
15 phenyl]-1,3,4-thiadiazol-2-yl]-benzoic acid, 30 ml of DMF and  
30 ml of dioxan is agitated for 5 minutes at 20°C and 1.55 ml  
of tributylamine and 7.74 ml of isobutyl chloroformate are  
added at 0/±5°C. The reaction medium is agitated for 3  
minutes at 0±5°C then for 3 hours at ambient temperature.

20 4.53 g of the deoxymulundocandine nucleus obtained as in  
Preparation 1 is introduced. Agitation is carried out for 16  
hours at 20°C, followed by concentrating to dryness. The  
residue is taken up in ethyl ether, followed by separating  
and washing with ethyl ether. After drying 7.8 g of product  
25 is obtained which is purified by chromatography on silica  
eluting with a methylene chloride-methanol-water mixture 86-  
13-1. 2.51 g of sought product is obtained.

STAGE B: 1-[4-oxo-N2-[[4-[5-[4-(pentyloxy)-phenyl]-1,2,4-thiadiazol-2-yl]-phenyl]-carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-echinocandine B.

By operating as in Stage B of Example 1, the sought product is obtained.

STAGE C: 1-[4-[(2-aminoethyl)amino]-N2-[[4-[3-[4-(pentyl-  
oxy)-phenyl]-1,3,4-thiadiazolol-2-yl]-phenyl]-carbonyl]-L-  
35 ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-L-serine-  
echinocandine B.

By operating as in Example 1, Stage C starting from the product of the preceding stage and ethylenediamine diacetate,

the sought product is obtained.

Isomer A            wt = 8 mg

Isomer B            wt = 9 mg

**EXAMPLE 7: trans 1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[5-  
5 [4-(pentyloxy)-phenyl]-1,3,4-thiadiazol-2-yl]-phenyl]-  
carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-  
L-serine-echinocandine B trifluoroacetate**

By operating as in Example 1, starting from the product of Stage B of Example 5 (50 mg) and (1S,2S)(+)1,2-diaminocyclohexane (15.6 mg), the sought product is obtained.  
Isomer A = 4 mg  
Isomer B = 6.5 mg

**EXAMPLE 8: trans 1-[4-[(2-aminocyclo-hexyl)-amino]-N2-[[4-[5-  
[4-(pentyloxy)-phenyl]-1,2,4-thiadiazol-2-yl]-phenyl]-  
15 carbonyl]-L-ornithine]-4-[4-(4-hydroxyphenyl)-L-threonine]-5-  
L-serine-echinocandine B trifluoroacetate (Isomer A and  
isomer B)**

By operating as in Example 1 Stage C starting from the product of Stage B of Example 5 (50 mg) and (1R,2R)-1,2-diaminocyclohexane (15.6 mg), the sought product is obtained.  
Isomer A = 8.8 mg  
Isomer B = 10.6 mg

**EXAMPLE: Pharmaceutical composition:**

Tablets were prepared containing:

25 - Product of Example 1..... 150    mg  
- Excipient s.q.f. .... 1    g  
(Detail of excipient: starch, talc, magnesium stearate).

**PHARMACOLOGICAL STUDY**

30

A - Inhibition of the glucan synthase of *Candida albicans*.

*Candida albicans* membranes were purified according to the process described by Tang et al Antimicrob. Agents Chemother 35, 99-103, 1991. 22.5 µg of membrane proteins are  
35 incubated in a mixture of 2Mm of 14C-UDP glucose (specific activity = 0.34 mCi./mmol, 50 µg of α-amylase, 1Mm of dithiotreitol (DTT), 1Mm EDTA, 100Mm NaF, 7µM of GTP-γ-S, 1M of sucrose and 50Mm of Tris-HCL (pH 7.8) in a volume of

100µl. The medium is incubated at 25°C for 1 hour and the reaction is terminated by adding TCA at a final concentration of 5%. The reaction mixture is transferred onto a pre-humidified glass fibre filter. The filter is washed, dried  
5 and its radioactivity is counted.

Mulundocandine is used as a positive control.

Control of the vehicle is carried out with the same quantity of 1% DMSO. The results obtained show that in this test the products of the invention show a good activity in  
10 particular the products of Example 1.

B - activity on the *Aspergillus fumigatus* enzyme.

The enzyme is prepared according to the process of Beaulieu et al. (Antimicrob. Agents Chemother 38, 937-944, 1994).

15 The protocol used is identical to the protocol described above for the enzyme of *Candida albicans* except that dithiotreitol is not used in the reaction mixture.

In this test the products show a good activity.